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Laser Treatment of Hemangiomas of the Larynx and Trachea

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Background and Objective: **Hemangiomas have a typical clinical course and may lead to life-threatening obstruction if the central respiratory tract is involved.**
Study Design/Patients and Methods: **This was observed in 32 children over a period of 20 years. The radiation parameters and application procedure of Neodymium:Yttrium-Aluminum-Garnet-laser (Nd:YAG-laser) therapy were adjusted for the degree of obstruction and the type of disease.**
Results: **The success rate was 93.8%, of which a maximum of one application was sufficient in 24 children (75.0%). Subglottic cicatricial stenosis was considered a laser-related complication.**
Conclusion: **Nd:YAG-laser treatment is a safe and effective therapeutic measure for eliminating respiratory tract obstruction caused by hemangiomas. Lasers Surg. Med. 23:221–232, 1998.** **© 1998 Wiley-Liss, Inc.**

Key words: central respiratory tract; endoscopic laser application technique; infantile hemangiomas; Nd:YAG-laser (1,064 nm)

INTRODUCTION

In 1913, Phillips and Ruh [1] were the first to find an angioma in the infantile larynx. In 1921, Sweetser [2] characterized laryngeal hemangiomas in children as a separate disease from the adult type. This was followed by numerous publications on infantile laryngeal hemangiomas treated by various procedures. Today, therapy is primarily endoscopic with the majority of reports on the use of the CO_2 laser (10,600 nm), usually referred to as "laser therapy" in this context. Thus a distinction must be made between the different lasers and individual techniques in order to evaluate the treatment methods. This study describes the endoscopic techniques used with the Neodymium:Yttrium-Aluminum-Garnet-laser (Nd:YAG-laser; 1,064 nm) and reports our experience in 32 children with hemangiomas of the central respiratory tract.

MATERIALS AND METHODS

Patients

From 1978–1997, 412 children were treated for respiratory tract stenosis in the Department of Pediatric Surgery of the University Hospital Benjamin Franklin. Hemangiomas were the cause of the ventilation disorder in 32 children (7.7%). The follow-up time was between 5 months and 11 years. All children were presented within the first year of life (Fig. 1). The youngest child was 6 days old and the oldest 11 months. The median age was 12 weeks; 62.5% were between 2–4 months and thus in the typical predilection age. The percentage of premature infants was 15.6%. Twenty girls (62.5%) and 12 boys (37.5%) were treated. Five children had other diseases: two had a cardiac defect, one had an aortic ring anomaly, one had facial paresis, and one had hydrocephalus.

Laryngotracheobronchoscopy

Endoscopy is always carried out in the central surgical tract under general anesthesia. We

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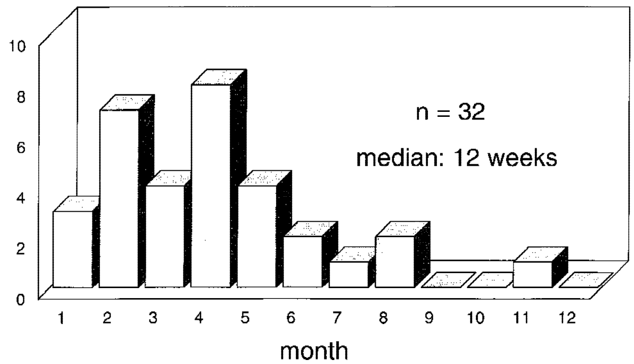

Fig. 1. Age distribution.

preferred to use a rigid bronchoscope with Hopkins' lens systems. Our findings were documented by video, print, or photography. At the beginning of endoscopy, the larynx was initially evaluated in the nonrelaxed child to better detect a laryngomalacia or recurrent paresis as the cause of stridor. Further examination and vocal-fold passage were only then performed under relaxation. Laser treatment was performed in the same session, if endoscopy revealed typical signs of a hemangioma. This was followed by 3-day postoperative antibiotic prophylaxis with cephalosporin of the second generation.

Classification of the Hemangiomas

It was important for the disease course and therapeutic procedure to differentiate between the various types of angiomas (Fig. 2). We grouped them into capillary (plane, planotuberous, tuberonodal) and cavernous (submucous, intramural, transmural, extramural) hemangiomas based on their morphology. Histological examinations were only performed in doubtful cases or in those with concomitant diseases. Samples were removed with the Nd:YAG-laser in the contact mode to avoid after-bleeding. The grade of lumen constriction was classified according to Cotton [3]. Grade I corresponded to 70% stenosis, grade II between 70 and 90%, grade III over 90%, and grade IV complete occlusion.

Laser Technique

Treatment was always performed with the Nd:YAG-laser (1,064 nm). We used a 0.4 mm bare fiber light conductor. Table 1 and Figure 3 summarize the techniques applied. For plane or planotuberous hemangiomas, we limited radiation to the transmucous noncontact mode. With an impulse duration of 0.05–0.2 second and 20–30 W power, this technique utilizes the selective absorption of blood, in which heat conduction into the surroundings prevents damage to the adjacent structures. Coagulation was achieved by the "polka dot" technique. In this connection, coagulated punctiform areas should be surrounded by untreated equally large mucosal areas. From the intact mucosa in the untreated zones, reepithelialization ad integrum can be performed via point coagulation which results in scar-free healing. With the selected parameters, the coagulation zone is 1–2 mm deep, thus cartilage damage is not expected. In tuberonodal hemangiomas, thrombosis of the surface components is first induced in the noncontact mode and subsequently resected in the contact mode. In submucous cavernous hemangiomas, interstitial laser therapy (ILT) is applied with 3–5 W power with continuous wave. The fiber centered in the tumor coagulates the tissue in a time-dependent and concentric manner. The mucosa remains intact (Fig. 4). The volume shift due to the coagulation process is endoscopically perceived as tumor shrinkage. Intra- and extramural hemangiomas can also be treated by ILT. In addition, the process can be endosonographically controlled by placing a transducer in the esophagus (Fig. 5).

RESULTS

Stridor was the most common indication for tracheoscopy and was seen in all children with involvement of the larynx or proximal trachea. Three children with involvement of the distal trachea or bronchi suffered recurrent bronchopneumonia. The most common preliminary noninvasive treatment was unsuccessful steroid therapy (12 patients). Previous unsuccessful treatment also included a tracheostoma in a 6-month-old boy and selective angiographic embolization in an 11-month-old girl. Eighteen patients (56.3%) had concomitant cutaneous hemangiomas, which were located on the head, throat, or neck in 17 children (94.4%). In the endoscopic examination, we found a total of 55 hemangiomas of the central respiratory tract in 32 children (Table 2). Twenty patients (62.5%) had solitary involvement (Fig. 6). Three children even had four localizations in the tracheobronchial system. The most frequently affected areas were the larynx and subglottic trachea in 23 children or 71.9% of the cases (Fig. 7). In three infants (9.4%), the main finding was found in the epilarynx, trachea, or bronchia. There were nine subglottic hemangiomas in the

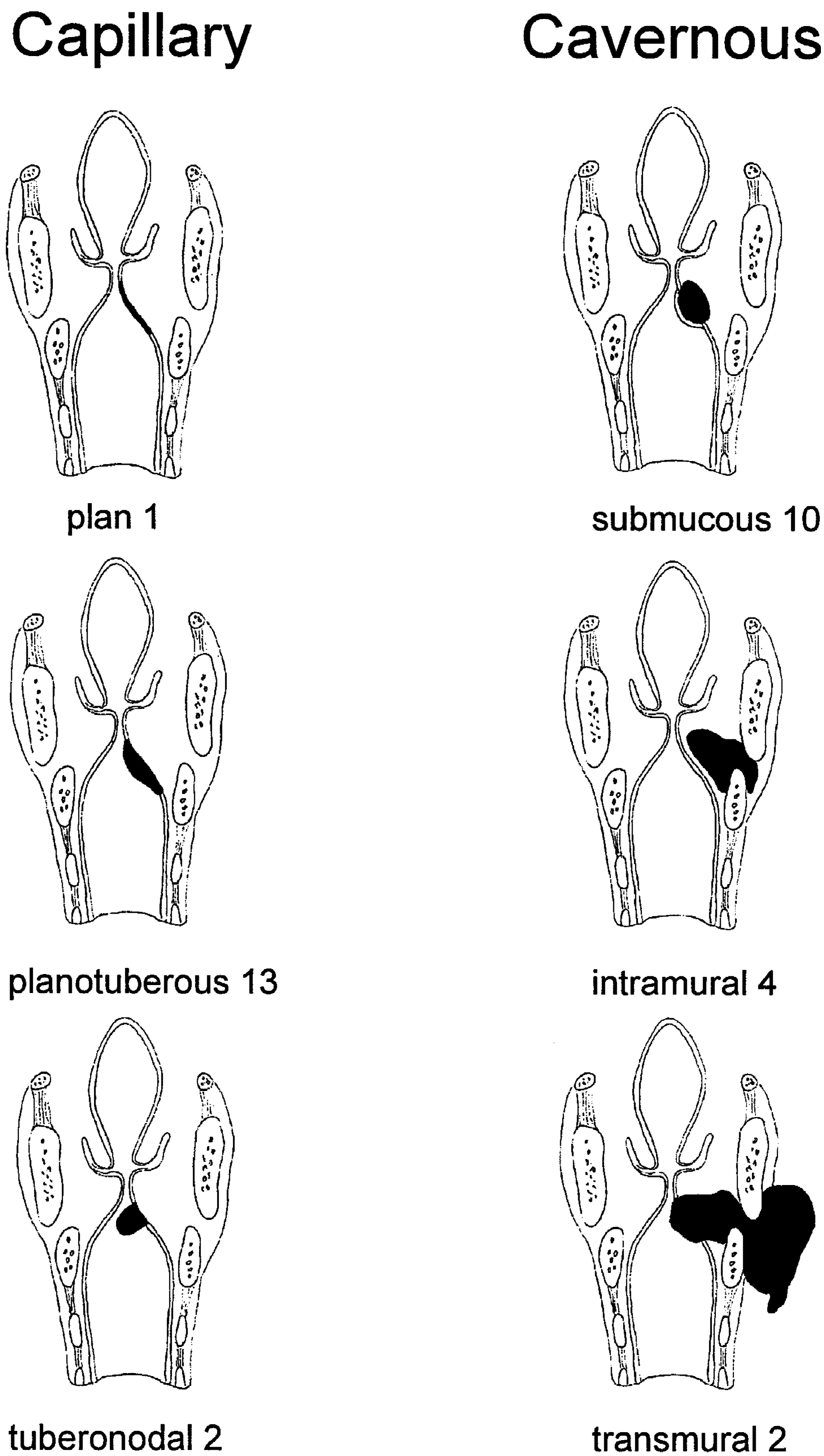

Fig. 2. Types and their appearance of laryngeal and tracheal hemangiomas in 32 children.

TABLE 1. Technique and Parameters of Laser Application in the Treatment of Different Laryngeal and Tracheal Hemangiomas [Neodymium:Yttrium-Aluminum-Garnet-laser (Nd:YAG-Laser, 1,064 nm; Bare Fiber Core Diameter 400 μm)]

Type of hemangioma	Irradiation technique	Synonyms	Tissue effect	Power (W)	Distance	Exposure time (seconds)	Interval (seconds)
Plan	non contact	transmucous	coagulation	20–30	2 mm	0.05–0.20	>0.20
Planotuberous	non contact	transmucous	coagulation	20–30	2 mm	0.05–0.20	>0.20
Tuberonodal	contact	resection	vaporization	15–30	at surface	0.10–0.30	>0.10
Cavernous	interstitial laser therapy	ILT	coagulation	3–5	interstitial	30–90	—

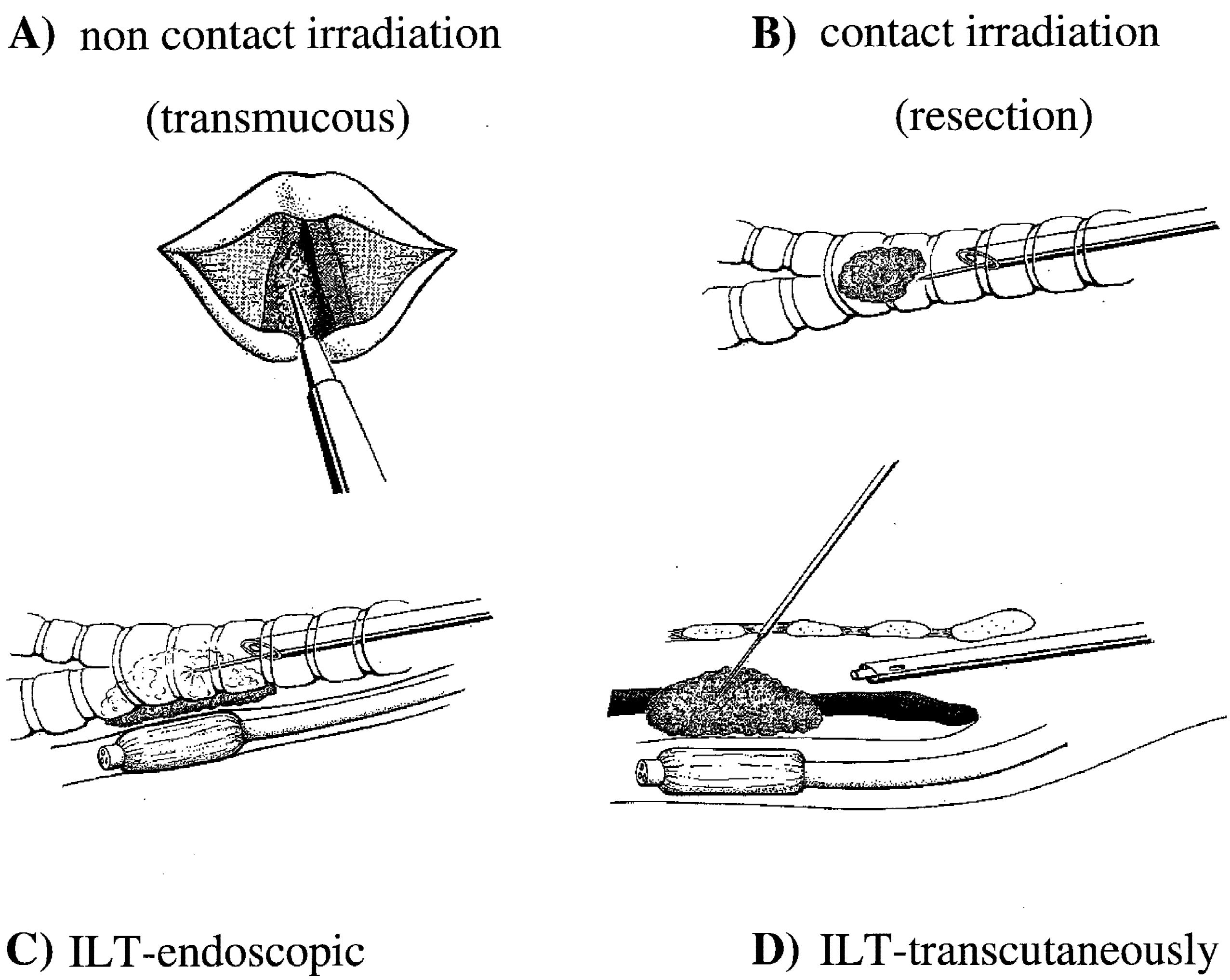

Fig. 3. Illustration of the laser technique in laryngeal and tracheal hemangiomas. **A:** Noncontact or transmucous irradiation. **B:** Contact technique or resection. **C:** Interstitial laser therapy (ILT) with the possibility of esophageal endo-ultrasound control–bare fiber via bronchoscope. **D:** ILT–bare fiber via transcutaneous punction.

left and seven on the right laryngeal wall. In another seven children, semicircular spread was seen on the posterior wall. Half of the children had a capillary hemangioma, in which the planotuberous type was predominant in 13 infants (Fig. 2). Submucous hemangiomas were the most common cavernous type.

After endoscopic detection of a hemangioma, Nd:YAG-laser therapy alone was the first therapeutic choice in 25 children. Four patients with capillary hemangiomas had a slight stenosis with less than 50% lumen constriction, so that treatment was initially delayed. Control endoscopy in an 8-week-old girl revealed progressive growth of a planotuberous subglottic hemangioma. Laser treatment was only carried out during the second

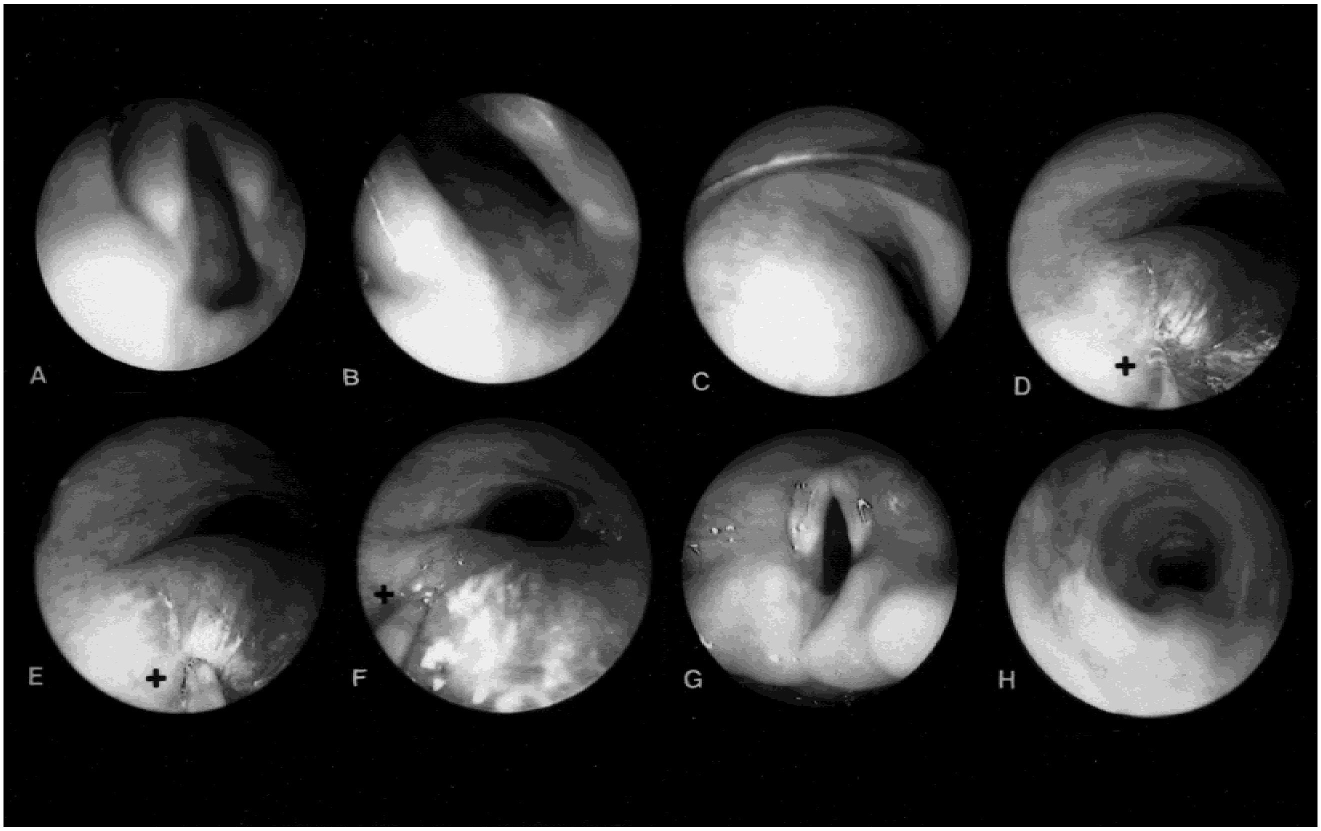

Fig. 4. **A:** Endoscopic view of interstitial laser therapy (ILT) of a laryngeal hemangioma in a 6-week-old boy. **B:** Typical aspect of a cavernous subglottic hemangioma in the left dorsolateral region. **C:** The compressible tumor is located in the submucous tissue; the mucosa is not involved. **D:** Bare fiber (mark) immediately before insertion into the hemangioma. **E:** Bare fiber (mark) in the center of the hemangioma. **F:** The tumor was reduced to a third of its initial volume after applying a 4 W power for 60 seconds. **G:** The larynx after 5 weeks. **H:** The subglottic region is almost completely disobliterated.

tracheoscopy. Thus, a total of 29 children were treated with the Nd:YAG-laser. In three children, observation alone was satisfactory until involution occurred. In two cases, laser therapy was combined with 5-day systemic steroid administration (5 mg/kg BW). In one case, we inserted a protective tracheostoma because of concomitant ulcerous laryngotracheitis. Ulceration of a subglottic hemangioma was observed in another patient. A 5-year-old boy additionally had hypoplastic cricoid cartilage. He required cricoid splitting and temporary tracheal stent therapy. In a preterm child who had required long-term respiration, this was combined with marked laryngomalacia. Although good regression of the subglottic hemangioma was achieved by a single transmucous laser application, the child could not be extubated due to persistent stridor. For this reason, a tracheostoma was created 10 weeks later in another center. The laryngeal cartilage stabilized, and the stoma was closed 2 years later. Surgery was necessary in three patients (9.4%) due to an additional malformation or a "complicated hemangioma."

A maximum of one therapeutic Nd:YAG-laser session was sufficient in 24 (75%) children (Table 3). Three laser applications were required in one child with a tuberonodal capillary hemangioma with grade III stenosis. Three or more sessions were necessary in two patients with the cavernous form. A high grade stenosis was present in all children undergoing more than two sessions (Table 4). Transmucous laser application in the noncontact mode was most frequently used (Table 5). It was the only type of treatment in grade I stenoses. Interstitial laser therapy was used in a total of 10 patients. In one case, the bare fiber was percutaneously inserted via a puncture needle into the transmural hemangioma. A single interstitial laser coagulation stopped the growth in the affected trachea. The higher the stenosis grade, the more frequent disobliteration by resection. One hemangioma with grade II stenosis and three with grade III stenosis were resected in the con-

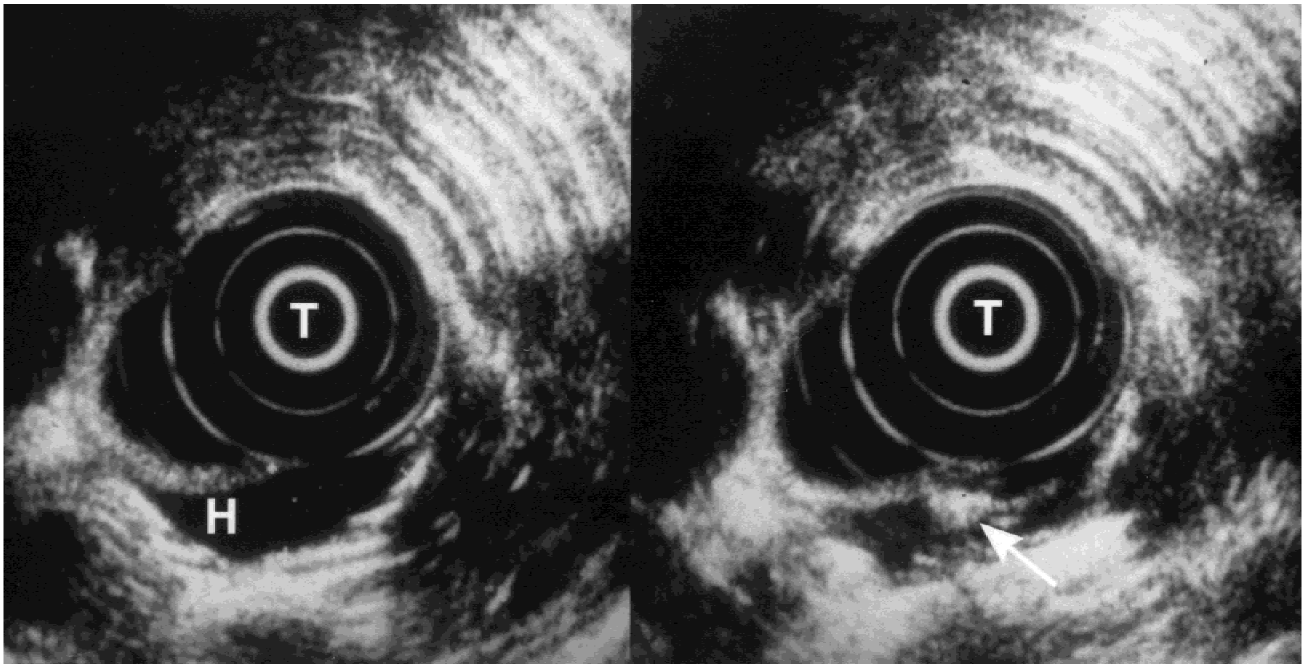

Fig. 5. Endo-ultrasound control of laser tissue interaction in a transmural hemangioma of the distal dorsal trachea. The 7.5 Mhz transducer **(T)** is placed in the esophageal lumen. On the right is the hyperechogenic coagulation effect (arrow) in the tracheal hemangioma **(H)** after 40 seconds of continuous interstitial laser irradiation with 4 W.

TABLE 2. Localization of 55 Hemangiomas in 32 Children

Localization	Number of hemangiomas	Percentage
Epilaryngeal	9	16.4
Glottic	6	10.9
Subglottic	23	41.8
Trachea	5	9.0
Bronchus	12	21.8

tact mode. Edematous swelling of the treated area may occur in the first 3 days after laser coagulation. The swelling regresses after about 4–5 days. The desired time point for extubation was after the protective intubation period. Immediate extubation was the goal in those children with a low-grade stenosis. This was performed in 12 children (Fig. 8). Five of eight children with grade I stenosis were already extubated in the operating room as well as 6 of 15 with grade II stenosis (Fig. 9). Five children were intubated for more than 1 week because of severe findings. In three of these five children, extubation was planned only after the second session. Extubation after 5 days was unsuccessful in two infants and reintubation was required. Angioma remnants were found after single Nd:YAG-laser application in 17 cases and in 10 after transmucous therapy in which zones of intact epithelium were intentionally left in place. In eight children, the remnants required therapy and were relasered. In the control tracheoscopy, granulomas were evidenced in a total of 11 cases, only four of which needed treatment. Single endoscopic Nd:YAG-laser removal was successful in all four patients. There were no intraoperative complications. Smoke development was negligible. We registered no hemorrhage, also not in the four cases, in which a biopsy specimen was taken. There was only one patient with postoperative complications due to Nd:YAG-laser therapy. A boy with an exulcerated tuberonodal subglottic hemangioma with grade III stenosis developed a subglottic cicatricial stenosis after resection in the contact mode. This has not yet been completely eliminated, and the child still has an open tracheostomy. With the exception of this child, all patients showed normal speech development in the further course. This particular child who was presented with a protective tracheostoma died from a tracheal cannule obstruction 3 months after successfully completing laser treatment. In three children, involution occurred spontaneously. Disobliteration was achieved in 24 of 29 children (82.7%) by only endoscopic therapy with Nd:YAG-laser. Another three children were

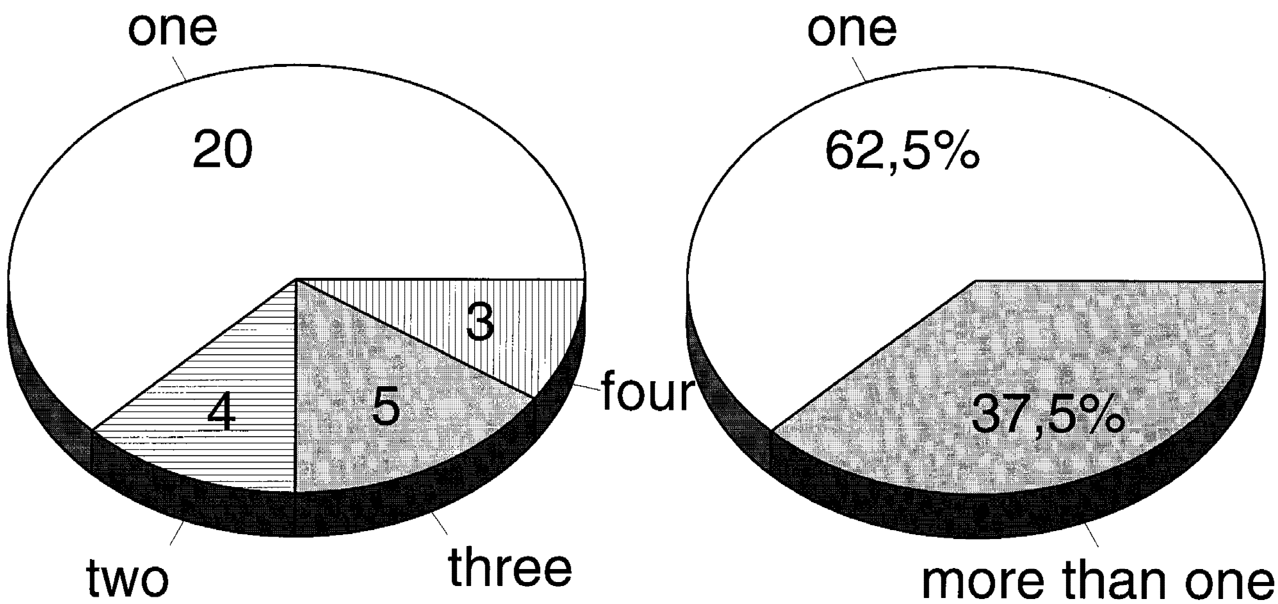

Fig. 6. Number of hemangiomas per child.

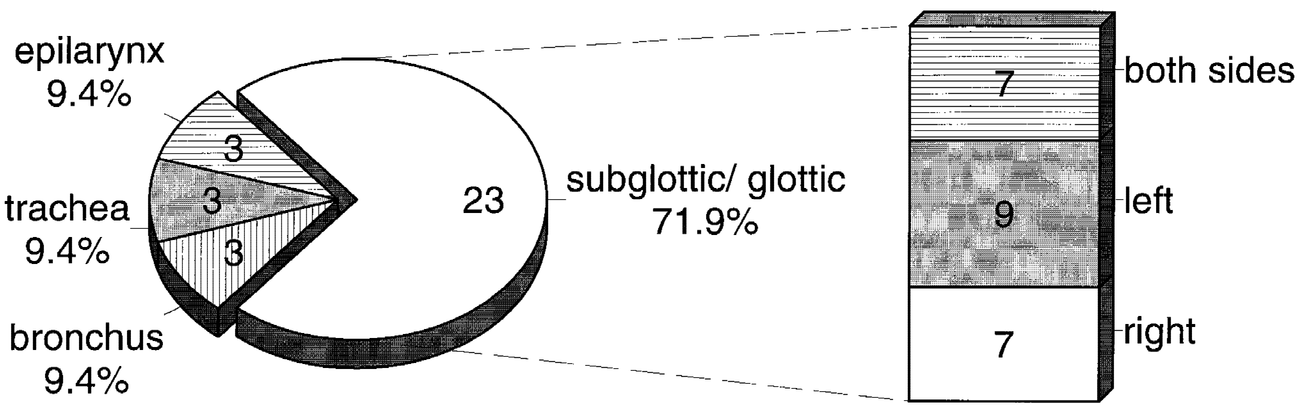

Fig. 7. Localization of main finding.

TABLE 3. Number of Laser Applications in Capillary and Cavernous Types of Hemangioma

Number	Capillary n = 16	Cavernous n = 16
0	3	0
1	10	11
2	2	3
3	1	1
>3	0	1

TABLE 4. Number of Laser Applications in Different Grades of Stenosis

Number	Grade I n = 8	Grade II n = 15	Grade III n = 9
0	3	0	0
1	4	11	5
2	1	3	2
3	0	1	1
>3	0	0	1

healed by a combination of surgery and laser application. Thus 27 of 29 lasered patients (93.1%) were successfully treated. If the children who did not receive laser treatment are included, 30 of 32 patients were healed by the applied therapeutic regimen. The overall success rate was 93.7%.

DISCUSSION

Hemangiomas are blood vessel neoplasms originating from the sprouting of vessels or their epithelia [4]. In the capillary forms, the size of the primitive endothelial canals corresponds to the

TABLE 5. Techniques in Different Grades of Stenosis

Technique	Grade I	Grade II	Grade III
Wait and see	3	0	0
Noncontact (transmucous)	5	7	3
Contact (resection)	0	1	3
Interstitial laser therapy (ILT)	0	7	3

capillary caliber, and in cavernous hemangiomas, the canals are clearly larger than the terminal vascular bed [5]. Three phases can be distinguished in the typical spontaneous course of a hemangioma. Progressive vessel growth corresponds to the proliferation phase which primarily occurs in the 6th to 8th week of life. Moreover, we differentiate early (1st to 5th year of life) from late involution (up to puberty), although only the capillary form regresses. However, 1–5% of this type never spontaneously regress. Central in the course of a hemangioma is possible rapid extensive growth. It is not yet manifest at birth but develops in the first few months of life. Approximately 99% of all hemangiomas appear in the first year of life [4]. In the case of exulceration, the spontaneous course is accompanied by scar formation. This is also valid in the evaluation of endolaryngeal or tracheal hemangiomas. The lumen of the subglottic region in a mature, eutrophic neonate has a diameter of ca. 5 mm [3]. The majority of the hemangiomas are found here. Considering the rapid increase in size of planotuberous and tuberonodal hemangiomas, it is not surprising that the lumen of the respiratory tract can be completely covered within a few days. A laryngeal or tracheal hemangioma should be considered an emergency and requires immediate attention. In capillary hemangiomas, there may be combined constriction of the lumen due to concomitant inflammatory and thus cicatricial stenotic changes. A prominent feature of this disease is stridor. This is initially audible on inspiration and later biphasically. It usually occurs in the 3rd to16th week of life (70%) with a high incidence in the 6th week (35%) [1,6,7]. The early form with dyspnea in the first few days of life is almost as equally rare (6%) as the late form (4%), in which symptoms only appear after the first year of life [1,6,7]. Stridor can be accompanied by coughing fits (14%), dysphagia, sitophobia, and growth disorder (10%). Vocal character changes in about 14% of the cases. Characteristic is the lack of symptoms after birth and in the first days of life. The constriction of the respiratory tract by hemangiomas differs in this way from other obstructive diseases in infancy, such as congenital subglottic stenosis, recurrent paresis, cricoid cartilage hypoplasia, laryngeal cysts, laryngeal valve, and laryngomalacia [3,8,9]. Girls have laryngeal hemangiomas approximately twice as frequently as boys [1,10,11,12]. In 40–60% of the cases there is concomitant involvement of the skin, primarily in the head, throat, and neck region, which was involved in 86% of the cases [5,6,11]. Predilection sites are the cheeks (36.8%), lips (17.6%), and neck (11.8%) [1]. Spontaneous involution of cutaneous hemangiomas may occur at the same time as that of the respiratory tract and is thus an indicator [5,9,10]. Also remarkable is the relatively high incidence (5.9%) of laryngeal hemangiomas combined with other congenital malformations [1], which was also observed in our group. A combination with cricoid hypoplasia has also been extensively described [13]. X-ray of the trachea in the sagittal and frontal ray path is helpful in the diagnostics. Computer tomography (CT) or magnetic resonance imaging (MRI) should be used in the case of a tentative diagnosis of extraluminal spread. The diagnosis, however, is confirmed by endoscopy combined with concomitant therapy. There is typically a soft, bluish-violet, compressible wide swelling directly under the vocal cords. This aspect defines the infantile type of laryngeal hemangiomas. This should be differentiated from the pedicled adult form found on or above the glottis [11]. A hemangioma can be assumed in a child with the corresponding clinical features and a directly subglottic swelling, even if the typical aspect like that found on the skin is not visible [12].

The larynx and subglottic trachea are by far the most frequently affected areas [1,6,12]. Angiomas are generally solitary manifestations but multiple localizations in the tracheobronchial system are also possible. In our group, 37.5% had more than one hemangioma. In subglottic hemangiomas, extension beyond the vocal folds into the supraglottic region is rare (6.5%) [1]. We found nine hemangiomas in the epilarynx; in three patients (9.4%), the main finding was located in this region. All subglottic hemangiomas originated in the posterior wall, but no predilection site was determined. It has been reported that 80.2% of the subglottic hemangiomas originate in the posterior wall and 42.8% extend to the left and 10.6% to the right side [1]. If the hemangioma is located submucously, only a mucosa-colored protrusion is seen. Extramural spread with infiltration or compression and simultaneous involvement of the cervical soft tissue or the mediastinum has also

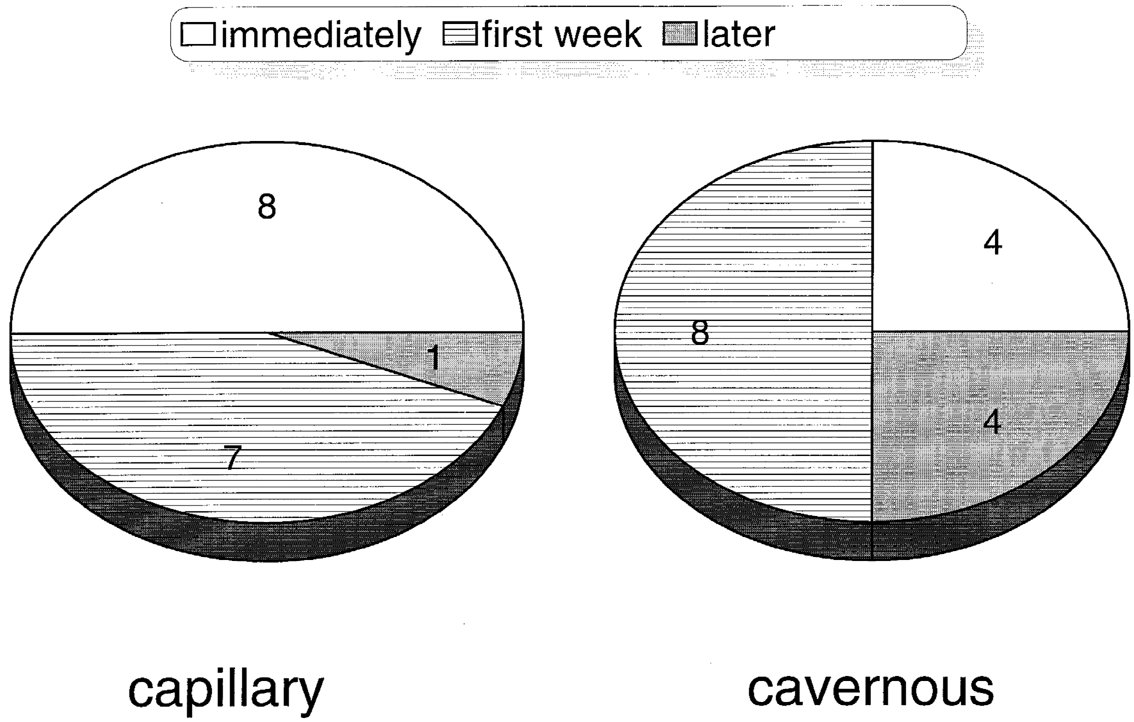

Fig. 8. Extubation time in capillary and cavernous types of hemangiomas.

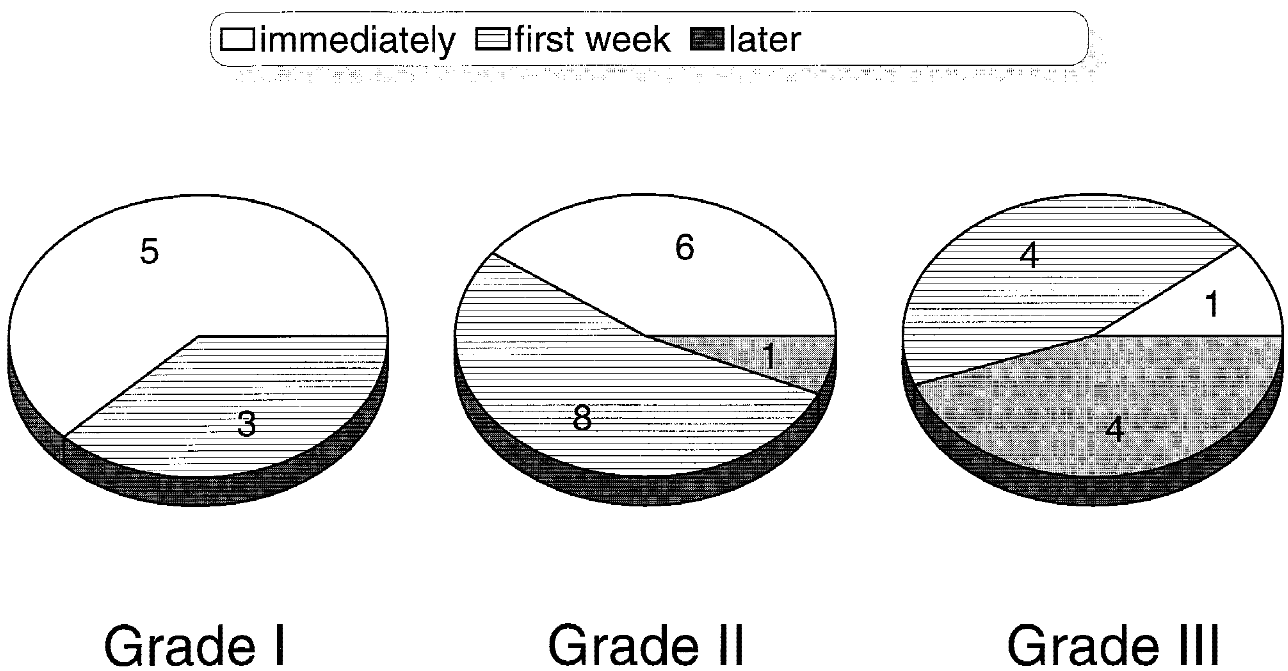

Fig. 9. Extubation time in different grades of stenosis.

been reported by others [14]. A biopsy is usually not necessary. They should only be performed in doubtful cases or in the presence of concomitant diseases. If a biopsy is necessary, the laser should be used to prevent bleeding. Until the middle of this century, there was still a 50% mortality [12]. Intubation was one of the first measures to eliminate dyspnea [2,15]. Intubation for the treatment of dyspnea caused by hemangiomas is justified by the extremely soft tube materials used today.

Bleeding seems to be less common than assumed [11]. We also did not see any. Radiation was the first method [15] applied for tumor reduction and was continued for a surprisingly long time [7,11,12]. Skepticism towards radiation was based on the danger of a radiogenic thyroid carcinoma [16]. The probability of radiogenic canceration is reported to be between 0.6–1% [1]. For this reason, other therapists recommended endolaryngeal radiogold spiking to sink the radioiodine doses in the thyroid [10,17]. In the surgical resection via a laryngofissure [5,13,16,18], less importance must be attached to bleeding than to the growth disorder of the infantile larynx after surgery.

The possible risks of recurrent paresis or tracheomalacia were reasons to abandon sclerotherapy [1,19]. Cryoprobes can be applied in the early stages [20–23]; but clinical symptoms are an indication that these have passed, and long application times are associated with a high risk of laryngeal and tracheal stenosis. Before laser application, laryngeal hemangiomas were also resected with the electrocauterizer [8,24]. The wide wound surface is associated with the risk of stenosis and the deep coagulation border the risk of malacia. Positive results were achieved in some cases by systemic corticoid administration [21,25], but, just as in interferon therapy, systemic side effects can be expected. These do not occur with local corticoid injection [6,26]. Since these measures for eliminating hemangiomas were not reliably effective and carried the risk of cicatricial stenosis formation, some authors recommended protective tracheostomy as the sole procedure [1,27]. However, it was also shown that even with intensive guidance, this is not without severe side effects. Severe complication rates of 13.4–48.6% were found in populations of 58 to 420 children [28]. Tracheostomy-related mortality was between 0–1.9%. In other surveys, only 36.0% of all children with subglottic hemangiomas were healed by protective tracheostomy alone after a mean follow-up of 1.8 years; mortality was still 33.3% [6]. The majority of children died of cannule-related respiratory insufficiency. This was also the reason for the only death in our population. Endoscopic laser therapy has made the creation of a tracheostoma an exception today. By 1980 Healey had already demonstrated that tracheostomy can be avoided by endoscopic application of the CO_2 laser (10,600 nm) [29]. This was followed by other treatment series which showed the importance of the CO_2 laser in the therapy of infantile subglottic hemangiomas [3,30,31]. The success rate was 93.5% in 31 children. The authors used 20 W power with a 0.05 second application time and a spot size of 0.7–2.0 mm. Complications included pneumothorax and subglottic cicatricial stenosis [32]. Thus, both the success and complication rates of CO_2 laser treatment corresponded to those of our Nd:YAG-laser therapy. However, not all parts of the respiratory tract can be easily reached in CO_2 laser treatment due to the rigid light conduction system. This resection procedure creates a wide wound. A stenosis may develop from the resultant scar [33]. For this reason, another study group suggested that hemangiomas should only be endoscopically treated if several laser applications are not expected [13]. The argon laser (451–514 nm) is also used in the treatment of infantile laryngeal hemangiomas [34]. Despite its high hemoglobin absorption, only plane or planotuberous forms can be successfully treated due to a penetration depth of only 1.5 mm [35]. With a spot size of 1 mm, 2 W power, and an application time of 0.15 second, this therapy is an extremely nontraumatic superficial treatment with nonconfluent spots.

Like other authors [36,37], we used the Nd:YAG-laser (1,064 nm). We could apply the techniques and experience we gained in treating over 4,000 cutaneous hemangiomas to endoscopic application for laryngeal and tracheal hemangiomas. The Nd:YAG-laser has the advantage that all locations, types, and stages of hemangiomas can be treated. The emitted light is more strongly absorbed in endothelial cells than in the surrounding tissue. It has low tissue absorption compared to CO_2 laser, and thus does not definitely destroy the surface. This enables deeper penetration of the laser energy and thus a deeper coagulation effect. The damage in the endothelial structures is greater than in the surrounding connective tissue. The deep coagulation effect is, however, associated with a risk of thermal damage to the cartilage. This may cause malacia of the larynx or trachea. To avoid adverse effects, it is preferable to treat protectively and repeat the laser therapy. This is particularly feasible if the grade of stenosis permits a two-session procedure. With the thin flexible quartz fiber, all sections of the larynx and tracheobronchial system can be reached up to the segmental bronchus level regardless of the child's size or age. Both intramural hemangiomas [38] and infiltrating extramural hemangiomas [14] have been described. We were also able to treat these types by interstitial therapy, which is not possible with the CO_2 laser

and recurrence follows if only the intraluminal part is ablated [38].

The aim of treatment is the disobliteration of the respiratory tract. There is an active regimen that dispenses with tracheostomy. The lumen must be rapidly dilated to prevent long-term intubation. On the other hand, the procedure must be protective to such a degree that cicatricial stenosis or cartilage damage does not occur. Treatment depends on the child's age, grade of stenosis, type and spread of the hemangioma, as well as the location of the mass. In capillary hemangiomas, progression must be expected in the first six months of life. One should take a wait-and-see attitude only with close endoscopic control. Early therapy is already recommended for plane and even for planotuberous hemangiomas with grade I stenosis. At this stage, transmucous Nd:YAG-laser therapy can be protectively applied with very short application times of 0.05–0.10 second. To a certain extent, this prematurely induces the natural regression process. In this way, we can avoid inflammatory complications which may develop with the growth of the hemangioma and considerably hamper treatment. If the main and segmental bronchi are affected, the plane forms should also be treated, since growth cannot be tolerated in this small lumen. Transmucous noncontact laser therapy should also be applied for planotuberous and tuberonodal types with moderate obstruction of the lumen, such as in grade II stenosis. Complication rates are lower for this technique than for resection. It is important for scar-free healing to leave an intact epithelium between the coagulation points. One to two sessions are sufficient for this therapy and usually lead to complete regression. In the case of submucous spread, interstitial laser treatment is the therapy of choice. The carbonization effect is negligible with low power. The size of the coagulation zones and the laser fiber increases with the duration of the application time. Based on applications on the body surface, we know that 300–500 Joules is sufficient for 5 mm coagulation zones. This corresponds to a laser power of 3–5 watts and application times of 60–160 seconds. Since the total volume of the hemangioma must not be coagulated, application times can be reduced to 30–90 seconds. The mucosa remains intact in interstitial treatment that completely preserves the protective epithelial barrier and mucociliary clearance. Inflammatory cicatricial complications are thus rare. Regression and shrinkage can also be induced in voluminous hemangiomas by interstitial laser application at several sites. Transcutaneous puncture under ultrasound control can also lead to regression of endoluminally inaccessible hemangiomas. Contact resection of hemangiomas should be avoided and restricted to exceptional cases of tuberonodal types with high-grade stenosis (III/IV). The excellent cutting effect of the Nd:YAG-laser enables completely bloodless single-session resection but creates the greatest mucosal damage which may lead to extensive scar formation as we saw in the boy with postoperative subglottic cicatricial stenosis. If the coagulation zone is deep, there is the additional risk of thermal and inflammatory cartilage damage which may lead to tracheomalacia, although it was not seen in our population. There is good endoscopic visibility throughout therapy because of blood-free conditions and minimal smoke development. Thus, intraoperative complications are rare. Slight postoperative edema permits the immediate or early extubation in most cases.

In summary, our experience shows that both the spontaneous course of hemangiomas and protective tracheotomy are associated with relevant complication rates. Thus, early endoscopy is indicated. With strict adherence to the application parameters, endoscopic Nd:YAG-laser (1,064 nm) therapy is a safe and protective local procedure for the treatment of all types of laryngeal and tracheal hemangiomas.

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